Optimizing Severe Acute Respiratory Syndrome Response Strategies: Lessons Learned From Quarantine

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Taiwan used quarantine as 1 of numerous interventions implemented to control the outbreak of severe acute respiratory syndrome in 2003. From March 18 to July 31, 2003, 147 526 persons were placed under quarantine. Quarantining only persons with known exposure to people infected with severe acute respiratory syndrome could have reduced the number of persons quarantined by approximately 64%. Focusing quarantine efforts on persons with known or suspected exposure can greatly decrease the number of persons placed under quarantine, without substantially compromising its yield and effectiveness. (*Am J Public Health*. 2007;97:S98–S100. doi:10.2105/AJPH.2005.082115)

Early in the 2003 global outbreak of severe acute respiratory syndrome (SARS), modes of transmission of SARS were unclear, and health officials used quarantine as 1 measure to contain this highly contagious emerging disease.[1] Broad quarantine measures, which included both people who had been in contact with others reported to be infected with SARS and travelers from SARS-affected areas, were implemented in Taiwan. To guide planning and resource allocation for future response strategies, we identified risk factors for development of SARS among quarantined persons in Taiwan.

TABLE 1—Number of Persons Quarantined, Number of Laboratory-Confirmed SARS Cases, and Number of SARS Cases, by Type of Exposure: Taiwan, March to July 2003

Type of Exposure	No. Quarantined	No. of Laboratory-Confirmed SARS Cases (%)	No. of SARS Cases (%)
Level A quarantine			
Classmates or teachers	16 794	1 (0.006)	9 (0.05)
Family members or relatives	8318	14 (0.17)	27 (0.32)
Coworkers or friends	4950	1 (0.02)	3 (0.06)
Homeless persons/shelter residents	622	0 (0.00)	1 (0.16)
Public transportation	147	0 (0.00)	0 (0.00)
Unprotected health care workers	2451	7 (0.29)	20 (0.82)
Same ward or nurse unit	419	1 (0.24)	2 (0.48)
Other nosocomial SARS exposure	10 751	9 (0.08)	27 (0.25)
Unknown	7803	3 (0.04)	13 (0.17)
Total	52 255	36 (0.07)	102 (0.20)
Level B quarantine			
Travelers from SARS-affected areas	93 665	3 (0.003)[a]	52 (0.06)
Within 3 rows of a person with SARS on a flight	1606	0 (0.00)	4 (0.25)
Total	95 271	3 (0.003)	56 (0.06)

Note. SARS cases include suspect, probable, and laboratory-confirmed cases. Among 3 laboratory-confirmed SARS cases, 2 patients developed symptoms and sought and received medical attention before returning to Taiwan. Level A quarantine was designed for persons who had known and, at times, had close exposure to individuals with SARS in health care facilities and other community and domestic areas. Level B quarantine was designed for travelers who sat on the same flight within 3 rows of a person infected with SARS or were returning from World Health Organization–designated SARS-affected areas (whether or not they were on the same airplane as a person infected with SARS).
[a]Adjusted for gender, age, and types of contact.

METHODS

Two types of quarantine were implemented during the SARS outbreak in Taiwan: level A and level B quarantine. Level A quarantine was designed for persons who had known and, at times, had close exposure to persons infected with SARS in health care facilities and other community and domestic areas. Level B quarantine was designed for travelers who sat on the same flight within 3 rows of a person infected with SARS or were returning from World Health Organization–designated SARS-affected areas (whether or not they were on the same airplane as a person infected with SARS; Table 1). We used logistic regression to evaluate the effects of gender, age, and type of exposure on the development of SARS among persons placed in quarantine. SAS version 8.2 (SAS, Cary, NC) was used in all of the statistical analyses. SARS cases were classified according to the World Health Organization case definition.[2]

RESULTS

From March 18 to July 31, 2003, 52 255 persons were placed under level A quarantine. Of these, 102 (0.2%) persons developed suspect, probable, or laboratory-confirmed SARS. Persons at highest risk for the development of SARS were health care workers who had unprotected exposure to a patient with SARS (0.82%), patients from the same ward or nurse unit with SARS patients (0.48%), family members or relatives of a SARS patient (0.32%), and other nosocomial SARS exposures (0.25%; Table 1).

During the same time period, 95 271 persons were placed under level B quarantine. Of these, 56 (0.06%) persons developed suspect, probable, or laboratory-confirmed SARS. Persons at highest risk for the development of SARS were those sitting within 3 rows of a SARS patient (0.25%; Table 1).

TABLE 2—Selected Risk Factors for the Development of SARS Among Persons Under Quarantine: Taiwan, March to July 2003

Variables	Level A Quarantine: Adjusted Odds Ratio (95% Confidence Interval)	Level A Quarantine: P	Level B Quarantine: Adjusted Odds Ratio (95% Confidence Interval)	Level B Quarantine: P
Gender				
Female	1.0		1.0	
Male	1.3 (0.8, 2.0)	.28	1.3 (0.6, 2.5)	.52
Age, y				
<20	1.0		1.0	
20–39	1.0 (0.5, 2.2)	.97	3.3 (0.4, 24.2)	.25
40–59	1.4 (0.6, 3.0)	.40	2.1 (0.3,15.7)	.48
≥60	2.7 (1.2, 5.9)	.01	10.5 (1.4, 80.5)	.02
Type of exposure				
Classmates or teachers	1.0			
Unprotected health care workers	17.5 (6.9,44.1)	<.001		
Family members or relatives	4.7 (2.0,11.0)	<.001		
Other nosocomial SARS exposures	3.5 (1.4, 8.6)	.006		
Same ward or nurse unit	3.0 (0.6,15.9)	.20		
Homeless persons or shelter residents	2.0 (0.2,16.4)	.52		
Coworkers or friends	1.0 (0.3, 4.0)	.98		
Travelers from SARS-affected areas			1.0	
Within 3 rows of SARS case on flight			3.2 (1.1, 8.9)	.03

Note. The model was adjusted for gender, age, and type of exposure. Level A quarantine was designed for persons who had known and, at times, had close exposure to SARS cases in health care facilities and other community and domestic areas. Level B quarantine was designed for travelers who sat on the same flight within 3 rows of a person infected with SARS or were returning from World Health Organization–designated SARS-affected areas (whether or not they were on the same airplane as a person infected with SARS).

Logistic regression was used to calculate risk factors for the development of SARS. Advanced age (>60 years) was identified as a risk factor for SARS in both level A and level B quarantine (Table 2). For level A quarantine, the odds ratios for developing SARS in this age group were 2.7; for level B quarantine, the odds ratios were 10.5. The probabilities of contracting SARS for the referent group (age<20 years) were different (0.09% vs 0.02% for level A vs level B quarantine). Quarantining only those with known SARS exposure could have reduced the number of persons quarantined by approximately 64%.

DISCUSSION

During the SARS pandemic of 2003, quarantine was used as a public health tool to contain the transmission of SARS in Taiwan, Canada, Singapore, Hong Kong, and Mainland China.[1,3–9] The types and intensity of quarantine measures implemented differed; evaluating the yield of quarantine measures can be useful for directing quarantine efforts in the future.

During the outbreak in Taiwan, 147 526 persons were placed under quarantine, and 158 (0.11%) persons developed suspect, probable, or laboratory-confirmed SARS. Persons under level A quarantine had a 3-times-higher rate of developing SARS than did persons under level B quarantine. Furthermore, persons initially placed in level B quarantine who were on the same flight within 3 rows of a person infected with SARS had rates of developing SARS similar to those in level A quarantine. Others have reported rates of developing SARS among quarantined persons that have been up to 10 times greater than those in this article.[4,10,11] The reasons for this difference in rates are unclear but could be related to varying types and durations of exposure, susceptibility to SARS, or likelihood of developing symptoms after infection.[10–13]

Emerging disease outbreaks require rapid responses, and government officials are often called on to make decisions regarding the implementation of control measures, such as quarantine, on the basis of limited knowledge about disease transmission dynamics. During the SARS response in Taiwan, there was scant information available that could have been used to definitively stratify or categorize contacts and travelers to avoid the unnecessary quarantine of low-risk individuals.

Our study found that the efficiency of SARS quarantine measures could have been improved by targeting quarantine efforts to persons with known or suspected exposure to SARS cases in hospitals, homes, communities, and airplanes. Restricting quarantine measures to only these persons could have reduced the number of persons quarantined by 64%, without compromising overall yield and efficiency. Similar findings have been reported from Beijing and Canada where transmission of SARS was limited to persons who had known exposure and close contact with SARS cases.[4,7–9] These data can be used to inform future responses and allocation of scarce public health resources if SARS returns and additional cost–benefit analyses are warranted. In addition, these findings support pursuing modeling to determine the most effective intervention strategies for other potential infectious disease emergencies, including pandemic influenza. ■

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Contributors

H-S. Kuo supervised all aspects of the implementation of this work. T-H. Wang originated the study, completed the analyses, and led the writing. K-C. Wei and C.A. Hsiung assisted with the writing of the article and synthesized the analysis. S.A. Maloney assisted with study and the writing. R.B. Eidex and D.L. Posey assisted with the writing. W-Y. Shih and W-H. Chou assisted with the study and analysis. All of the authors helped to conceptualize ideas, interpret findings, and review drafts of the article.

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Human Participation Protection

No protocol approval was needed for this study. According to Taiwan's Communicable Disease Control Act, SARS is classified as a first category notifiable communicable disease. All individuals suspected of being infected with SARS are required to report to the Taiwan Centers for Disease Control, which would subsequently collect samples for further study within 24 hours. In summary, in accordance with Taiwan's Communicable Disease Control Act, we collected the information and performed the tests for the purpose of disease control.

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